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Planning Tools for Estimating Radiation Exposure at the National Ignition Facility

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Disclaimer

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In a facility like the National Ignition Facility (NIF), where high-energy neutron fluxes are intermittently present, it is important to accurately analyze the ambient radiation exposure due to the activation of surrounding materials and their subsequent decay, principally by gamma emission. Target Bay (TB) components, like target positioners, diagnostic instrument manipulators (DIMs), as well as utilities and surrounding structural materials are activated during yield shots. The present work is motivated by the need for the development of an automated mechanism that allows for simultaneous analysis of contribution resulting from all activated structures to the radiation environment inside the target bay.

A set of tools is developed to compute and help in minimizing the radiation exposure to workers in the NIF. The first tool, AAMI (Automated ALARA-MCNP Interface) provides an efficient, automated mechanism to perform the series of calculations required to create dose rate maps in the facility with minimal manual user input. Starting from a detailed model of the TB, the first step consists of determining all the components that can potentially be activated. The neutron flux spectra in all these components are then computed from a forward Monte Carlo neutron transport simulation with the MCNP code. The neutron flux spectra are used to perform activation analyses of the various components using the activation code, ALARA, producing inventories of radioisotopes and gamma spectra from the decay of these isotopes at specified cooling times. These gamma sources are then sampled on an activated component by component basis in a second forward MCNP photon transport simulation and propagated through the TB model to obtain a 3-dimensional radiation dose rate map using the ICRP-74 fluence to effective dose conversion coefficients. The MCNP code was modified to simultaneously and efficiently sample the gamma rays from all activated components. These dose rate maps are stored in a database along with radionuclide inventories for activated components that may require handling.

The second tool, NIF Exposure Estimation Tool (NEET), is a web application that combines the information stored in the database with a given shot schedule to compute and display the dose rate maps as a function of time. NEET is a work planning tool, and is used to determine stay-out times for workers following a given shot or set of shots and to help in estimating integrated doses associated with performing various maintenance activities inside the target bay. Dose rate maps of the TB are generated following a 10^{16} D-T shot and will be presented in this paper.

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